METAL JUMPS ACROSS SLOSHING COLD FRONTS: THE CASE OF A496

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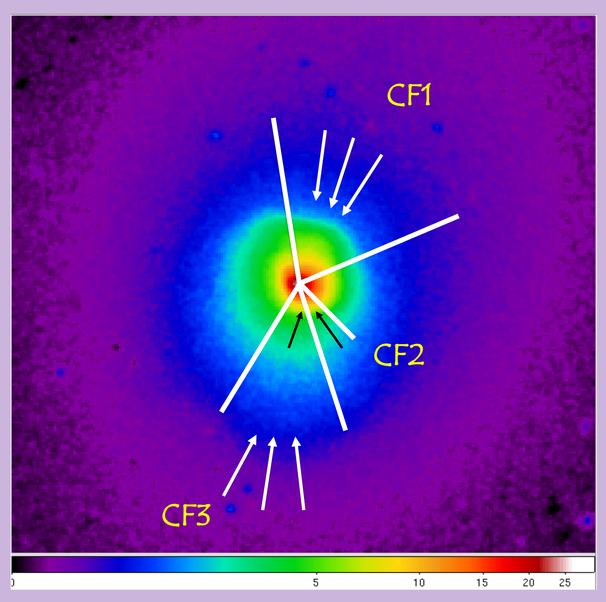
A496 SURFACE BRIGHTNESS – EPIC IMAGE



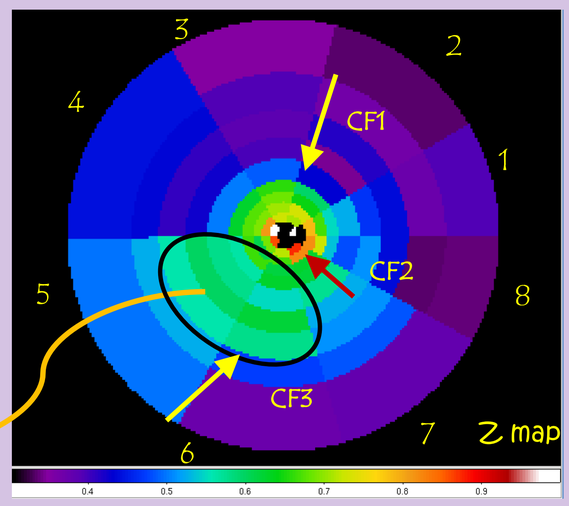
SLOSHING COLD FRONTS IN A496

After the discovery of cold fronts, several clusters hosting these features have been found (Ghizzardi et al. 2010). Cold fronts in cool core clusters are thought to be induced by minor mergers and to develop through a sloshing mechanism.
Among the properties characterizing cold fronts, the **metal abundance behavior across the discontinuity is still an important missing piece of the puzzle.**
Abundance discontinuities across sloshing cold fronts have been observed in some cool core clusters (Centaurus, Perseus, 2A0335+096, Ophiuchus, A2204) **however Dupke et al. (2007) did not find them in A496.**
We analyze a long (120 ksec) XMM-Newton observation of A496 to study the metal distribution in this cluster and its correlation with the cold fronts positions.

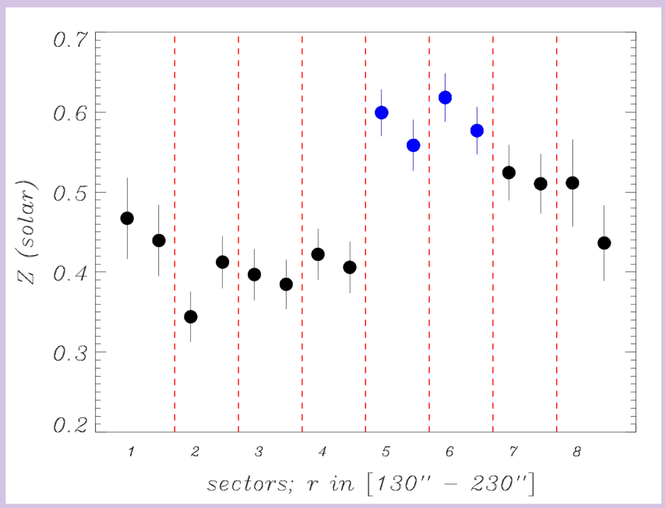
A496 is a nearby ($z \sim 0.032$) bright cool core cluster.
We detected (Ghizzardi et al. 2010) three cold fronts.
The most prominent cold front (CF1) is located in the north direction ~ 75 kpc from the X-ray peak.
The second (CF2) and the third (CF3) cold fronts are located south of the core some 35 kpc and 160 kpc respectively.
Dupke et al. 2007 find another cold front close to the center, at ~ 16 kpc in the east direction, but they do not detect the outermost southern cold front.
Dupke et al. 2007 used a Chandra observation to inspect the metal profile across the northern and inner southern cold fronts.
They do not find any metal discontinuity across the fronts.

THE ABUNDANCE MAP

We build the metallicity map for A496.
We divided the cluster into sectors and rings in such a way as to match cold fronts positions.
In each bin we have ~ 50000 cts .
We fit spectra using a mekal model.
Errors for Z best fit values are in the range 2.5% - 6%.



A **high metallicity region** is located in the south-east, in the region just inside the outermost cold front.

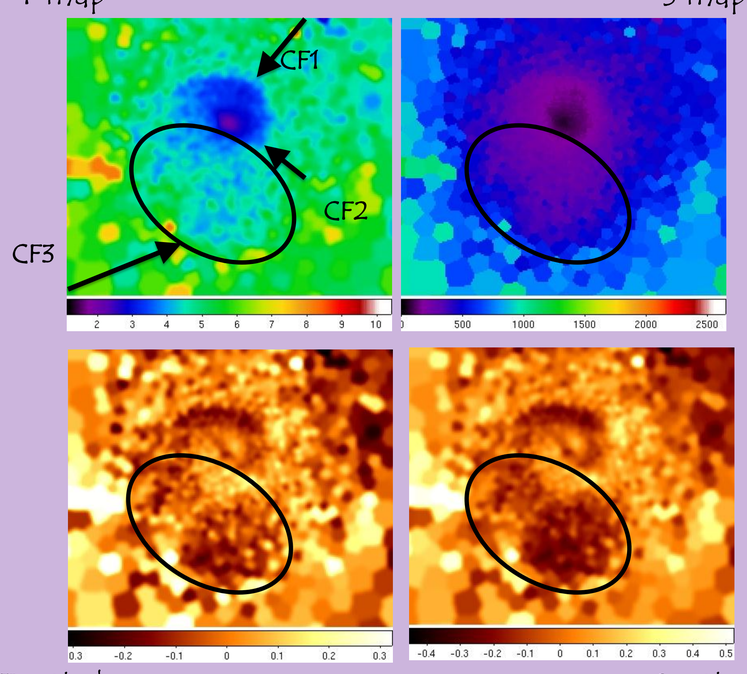


The plot reports the abundances measured in all the sectors lying at 80-160 kpc. Blue points mark the bins lying within the black ellipse drawn in the map, corresponding to the south-east region.

The metallicity in this region is higher than the metallicity measured in any other sector of the cluster at the same distances.

TEMPERATURE AND PSEUDO - ENTROPY

T map S map

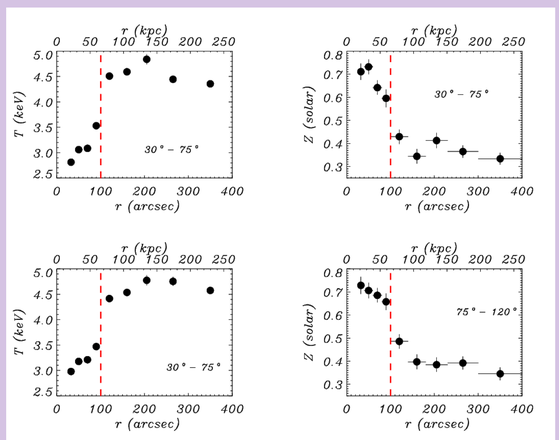


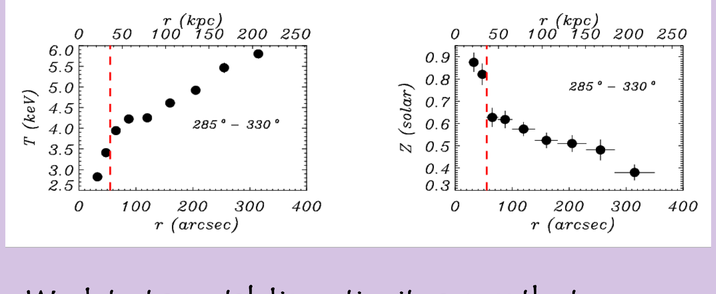
T residual map S residual map

We derived the **temperature (T) and pseudo-entropy (S)** maps using a WVT tessellation + Broad Band Fitting algorithm (Rossetti et al. 2007). The T and S maps (upper panels) show the typical spiral-like pattern which can be found when a sloshing cold front is developing in a cool core. The spiral pattern can be better recognized in the T and S residual maps (lower panels). Cold fronts are marked in the first panel but can be easily observed in all the maps. The outermost cold front CF3 corresponds to the southern extension of the spiral.
The high metallicity region matches this tail of the spiral.

METAL DISCONTINUITIES ACROSS COLD FRONTS

CF1

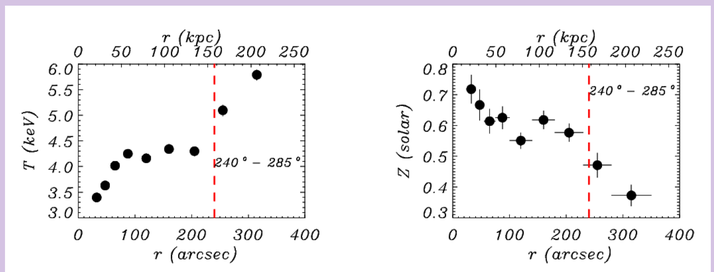




We detect a metal discontinuity across the two innermost cold fronts, CF1 and CF2. The red dashed lines mark the cold front positions (~35 kpc and ~75 kpc respectively).

CF2

On the contrary **no jump is detected in the outermost cold front** (CF3).



CF3

GLOBAL PICTURE FOR METAL DISTRIBUTION IN SLOSHING COLD FRONTS

So far, A496 was the only cluster hosting sloshing cold fronts and showing no metal jump across the fronts. We use a long XMM-Newton observation to study metal distribution in A496 and find clear discontinuities across the two innermost (~ 35 and 75 kpc) cold fronts. We do not find a metal jump across the outermost cold front but an excess of metal abundance is detected in the region where this cold front is located.
These two different behaviors can be interpreted within a sloshing picture for cold fronts.
When a minor merger event triggers the sloshing mechanism in the cool core of a relaxed cluster, the central cool and metal rich gas is displaced outwards in a hotter and less abundant region of the cluster. This displacement creates the cold front feature and a metal discontinuity across the front is expected. As the colder gas sloshes towards the potential well center, it carries the metals so it keeps its high metallicity and the metal jump across the head of the front is preserved. CF1 and CF2 are observed at this stage of the sloshing process.

On the contrary, when the cooler and richer gas starts flowing back towards the center, the external cold front lying on the outer extension of the spiral detaches and it adiabatically expands outwards. The higher metal gas expands and then it will slowly move back towards the center. Cold gas and metals spread out. No metal discontinuity is detected but the region keeps a higher global metallicity. Cold front CF3 is observed during this stage .